

What Is Claimed Is:

- 1 1. A method of manufacturing a micro-electromechanical
2 device comprising the steps of:
3 forming a moving member on a first substrate such that a
4 first sacrificial layer is disposed between the moving member
5 and the substrate;
6 encapsulating the moving member, including the first
7 sacrificial layer, with a second sacrificial layer;
8 coating the second sacrificial layer with a first film
9 formed of a material that establishes an hermetic seal with
10 the substrate; and
11 removing the first and second sacrificial layers.
- 1 2. The method of claim 1, further comprising the step of
2 forming an opening in the first film prior to removing the
3 first and second sacrificial layers.
- 1 3. The method of claim 2, wherein said opening forming
2 step is performed during said coating step.
- 1 4. The method of claim 2, wherein said opening forming
2 step is performed after said coating step.
- 1 5. The method of claim 2, further comprising the step of
2 sealing the opening after the first and second sacrificial
3 layers are removed.

1 6. The method of claim 5, wherein said sealing step is
2 performed by coating the first film with a second film formed
3 of the same material as the first film.

1 7. The method of claim 2, wherein said step of removing
2 the first and second sacrificial layers includes the step of
3 immersing the switch in one of a reactive liquid solution, a
4 reactive gas, and a supercritical fluid.

1 8. The method of claim 1, further comprising the step of
2 forming a conductive layer on the first film.

1 9. The method of claim 8, further comprising the step of
2 coating the conductive layer with a second film such that the
3 conductive layer is disposed between the first and second
4 films.

1 10. The method of claim 9, wherein the second film is the
2 same material as the first film.

1 11. The method of claim 8, further comprising the step of
2 connecting the conductive layer with a second circuit that
3 causes the conductive layer to act as a counter electrode.

1 12. The method of claim 1, wherein the miniature
2 electromechanical device is formed on a substrate with other
3 circuit components and the first film covers only the
4 electromechanical device.

1 13. The method of claim 1, further comprising the step of
2 mounting the first substrate on a second substrate carrying
3 other circuit components.

1 14. The method of claim 5, further comprising the step of
2 coating the movable member with an anti-stiction film prior to
3 said sealing step.

1 15. The method of claim 1, wherein a plurality of
2 microelectromechanical devices are formed on the first
3 substrate and encapsulated by the first film, and further
4 comprising the step of cutting the substrate to separate the
5 microelectromechanical devices.

1 16. A micro-electromechanical system (MEMS) device
2 comprising:
3 a first substrate;
4 a first control circuit formed on said first substrate and
5 including a first actuation element;
6 a movable member formed on said first substrate in spaced
7 relation to said first actuation element, said movable member

8 being electrically conductive and movable in the direction of
9 said first actuation element; and

10 a helmet defining a hermetically sealed chamber around
11 said movable member, said helmet being formed by removing a
12 sacrificial layer between said movable member and said helmet.

1 17. The MEMS device of claim 16, and further comprising an
2 inert gas disposed within said hermetically sealed chamber.

1 18. The MEMS device of claim 16, and further comprising a
2 second control circuit with an actuator element disposed
3 within said helmet.

1 19. The MEMS device of claim 16, and further comprising a
2 plurality of moving members formed on said substrate, wherein
3 said helmet defines a plurality of hermetically sealed
4 chambers around said movable members.

1 20. The MEMS device of claim 16, wherein said helmet is
2 formed of a silicon oxynitride film.

1 21. The MEMS device of claim 16, wherein said helmet has
2 tapered sides.

1 22. A method of fabricating a micro-electromechanical
2 system (MEMS) device comprising the steps of:

3 forming a control circuit with an actuating element on a
4 substrate;

5 defining a movable member above the actuating element by
6 applying a first sacrificial layer over the actuating element,
7 depositing a conductive material such that the material
8 extends from the circuit to cover the first sacrificial layer,
9 and removing portions of the sacrificial layer around the
10 movable member but not between the moving member and the
11 substrate;

12 encapsulating the moving member on all sides with a second
13 sacrificial layer;

14 coating the second sacrificial layer with a material that
15 forms an hermetic seal with the substrate; and
16 removing the first and second sacrificial layers.

1 23. The method of claim 22, wherein said step of applying
2 a first sacrificial layer includes tapering edges of the first
3 sacrificial layer.

1 24. The method of claim 23, wherein said step of applying
2 a second sacrificial layer includes tapering edges of the
3 second sacrificial layer.

1 25. The method of claim 24, wherein said tapering step
2 includes baking the first and second sacrificial layers after
3 curing.